Document 6

FISHERY LOGBOOK DATA FOR PACIFIC SARDINE

Prepared for
WORKSHOP ON ENHANCING STOCK ASSESSMENTS OF PACIFIC SARDINE IN THE CALIFORNIA CURRENT THROUGH COOPERATIVE SURVEYS
June 1-3, 2010
La Jolla, California

Kevin T. Hill
NOAA National Marine Fisheries Service
Southwest Fisheries Science Center
8604 La Jolla Shores Drive
La Jolla, California, USA 92037

I. Introduction and Background

Stock assessment models often use fishery logbook data as a source of information regarding changes in population abundance over time. The logbook data are used to relate amount of catch (weight or number) obtained for a standardized amount of fishing effort (e.g. hours or days fished, number of hooks, search time), commonly referred to as catch-per-unit-effort (CPUE). The relationship between CPUE index 'I' and actual population size 'P' is described by the scaling parameter 'q', also known as the catchability coefficient, where:

$$I = q \bullet P$$

Analysts constructing CPUE time series from logbook data must examine the following questions prior to including the data in a stock assessment model: 1) does the fishery sample a sufficient amount of the population to accurately represent overall trends?; 2) do changes in CPUE represent changes in population size or just local availability (e.g. seasonal movement onshore-offshore or north-south); 3) is q constant over time, or has it changed due to fishing practice or regulations?; 4) does q remain constant as population density changes? These questions are interrelated, but if not considered (particularly the assumption of constant catchability) then there is serious risk of systematic bias in the time series and assessment results.

II. Problems Associated with CPUE in Coastal Pelagic Species Assessments

MacCall (1976) examined CPUE and abundance data from the historic Pacific sardine fishery (1932-50), as originally published by Murphy (1966). MacCall's analysis revealed that q was inversely proportional to population abundance, i.e., the catchability of sardine increased as the population declined (see Figure 1). An inverse relationship between catchability (q) and population size (P) means that CPUE will most likely remain stable as the population undergoes a decline. This is a highly undesirable characteristic for a stock assessment time series as it will ultimately result in biased population trends and misinformed management decisions.

Higher catchability with decreasing stock size is not unique to Pacific sardine. The phenomenon has been documented during collapse of other major coastal pelagic fish stocks, for instance,

Atlantic menhaden (Shaaf 1980), Norwegian herring (Ulltang 1976), the South African sardine (Shelton and Armstrong 1983), and most notably, the Peruvian anchoveta (Csirke 1989). Csirke's (1989) analysis of the Peruvian anchoveta collapse illustrates a striking inverse relationship between abundance and *q*, as shown in Figure 2. The lack of relationship between biomass and CPUE is shown in Figure 3.

A commonly accepted explanation for this phenomenon is that coastal pelagic fish populations, including Pacific sardine, tend maintain a relatively constant density across the range of their distribution, but as a population collapses it will continue to aggregate in areas with suitable habitat (e.g. offshore to inshore, or north to south) - this is typically the nearshore habitat where the fisheries primarily operate. Thus, the density of fish schools in the nearshore regions and the amount of effort it takes for fishing vessels to locate these schools will remain relatively stable as the population collapses from offshore to onshore areas. This was certainly the case during the previous Pacific sardine collapse as population receded into the Southern California Bight and the fishery remained active until the very end.

III. Current Sardine Logbook Programs and Their Potential Use

While logbook data may not provide useful time series for the Pacific sardine stock assessment, there are other potential uses for the data, including:

- data for improving ongoing sardine habitat prediction models
- optimizing survey design
- economic data for PFMC or other regulatory analyses
- documenting fishing grounds in the event that MPAs are proposed for those areas
- improving Total Catch Accounting (MSRA 2006), including by-catch and discards

Sardine logbooks are currently mandated by the states of Washington and Oregon and data have been collected since the year 2000. The logbooks and databases are managed by WDFW and ODFW. Spatial coverage is typically confined to areas between central Oregon and central Washington within 50 miles of shore (Figures 4 & 5). Fishing activity typically occurs between July and September. California does not require logbooks for CPS finfish, but does require logbooks for the market squid fishery which is composed of many sardine vessels. A federal logbook program for the CPS finfish fleet does not exist, but one could theoretically provide uniform coast-wide data collection for the other purposes listed above.

Literature Cited

Csirke, J. 1989. Changes in the catchability coefficient in the Peruvian anchoveta (*Engraulis ringens*) fishery. pp. 207-219 *In*: Pauly, D., P. Muck, J. Mendo and I. Tsukayama, Editors. The Peruvian upwelling ecosystem: dynamics and interactions. *ICLARM Conference Proceedings* 18. 438 p.

MacCall, A. D. 1976. Density dependence of catchability coefficient in California Pacific sardine, *Sardinops sagax caerulea*, purse seine fishery. *Calif. Coop. Oceanic Fish. Invest. Rep.* 18: 136-148.

Schaaf, W.E. 1980. An analysis of the dynamic population response of Atlantic menhaden, *Brevoortia tyrannus*, to an intensive fishery. *Rapp. P.-V. Réun. CIEM* 177: 243-251.

Shelton. P.A. and M.J. Armstrong. 1983. Variations in parent stock and recruitment of pilchard and anchovy population in the Southern Benguela system, p. 1113-1132. *In* G.D. Sharp and I. Csirke (eds.) Proceedings of the Expert Consultation to examine changes in abundance and species composition of neritic fish resources. San Jose, Costa Rica. 18-29 April 1983. *FA0 Fish. Rep.* 291 Vol. 3.

Ulltang, 0. 1976. Catch per unit of effort in the Norwegian purse seine fishery for Atlanto-Scandian (Norwegian spring spawning) herring. FA0 Fish. Tech. Pap. 155: 91-101.

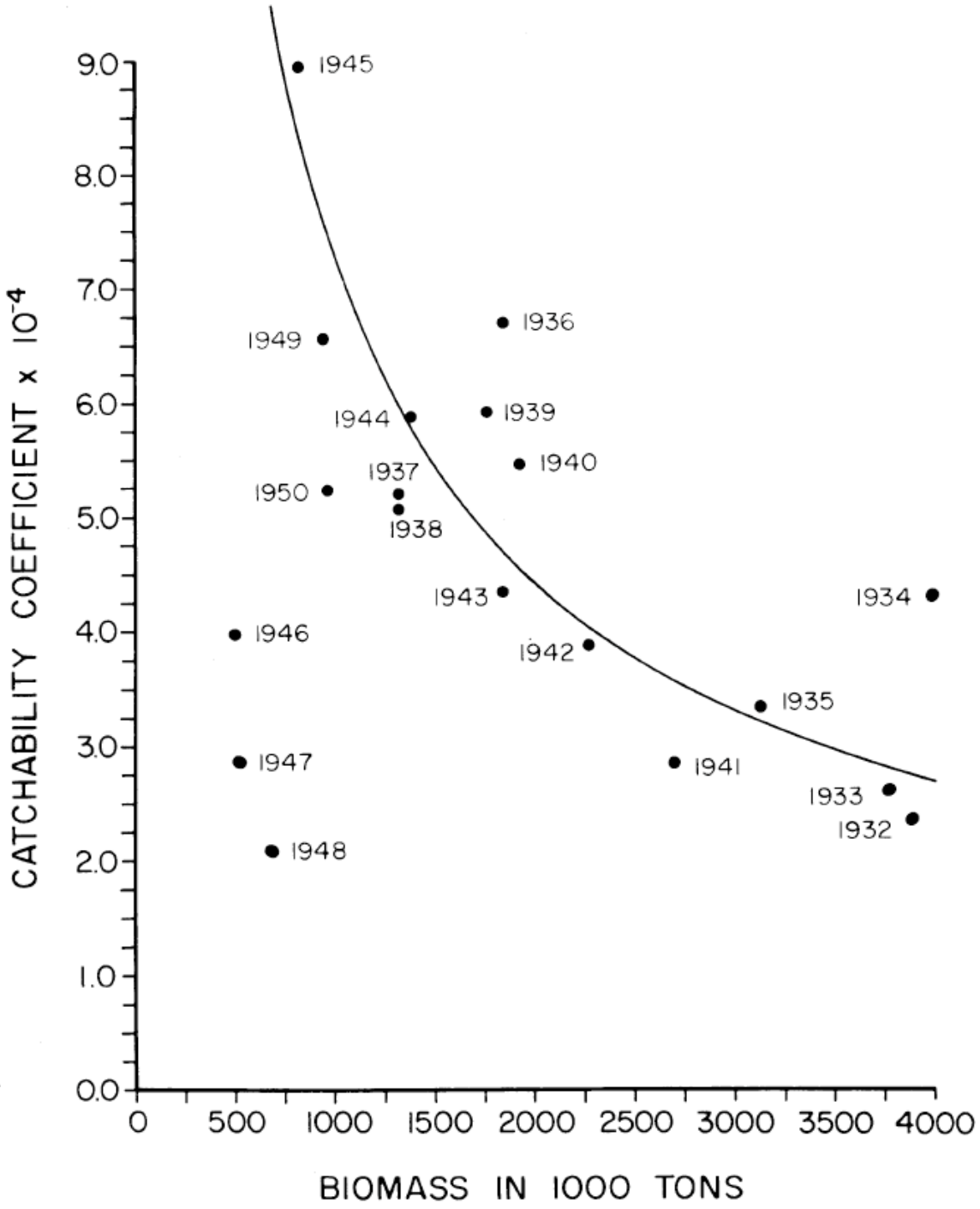

Figure 1. Catchability coefficient *q* as a function of Pacific sardine population size (figure from MacCall 1976; data from Murphy 1966).

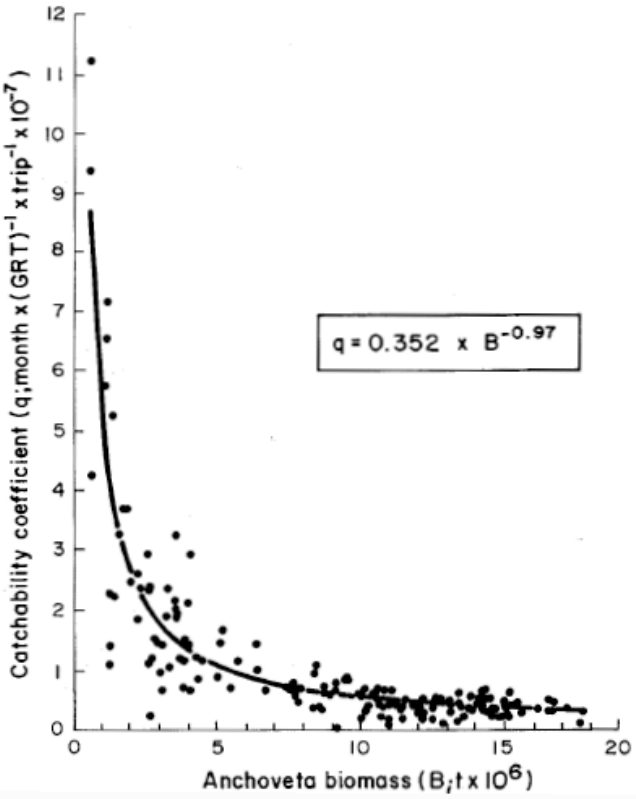

Figure 2. Relationship between monthly catchability coefficient and the mean exploited stock biomass of the Peruvian anchoveta (*Engraulis ringens*), between 1960 and 1982 (figure from Csirke 1989).

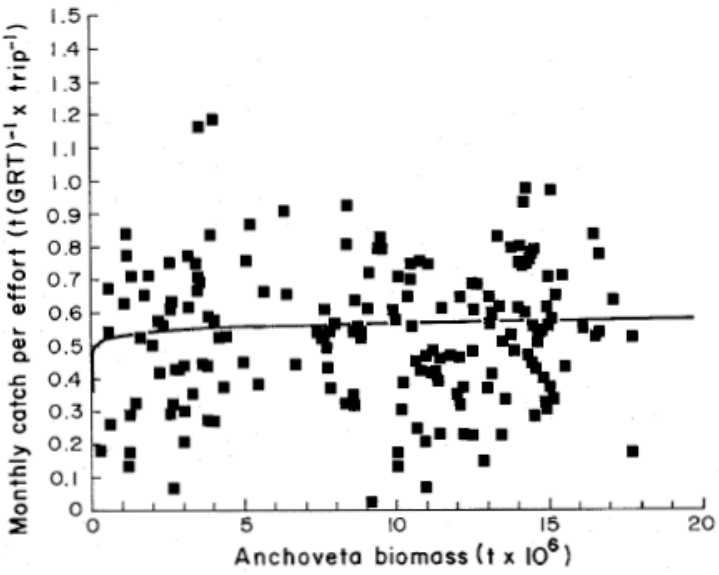

Figure 3. Relationship between monthly catch per unit of effort and the biomass of the Peruvian anchoveta (*Engraulis ringens*) between 1960 and 1982 (figure from Csirke 1989).

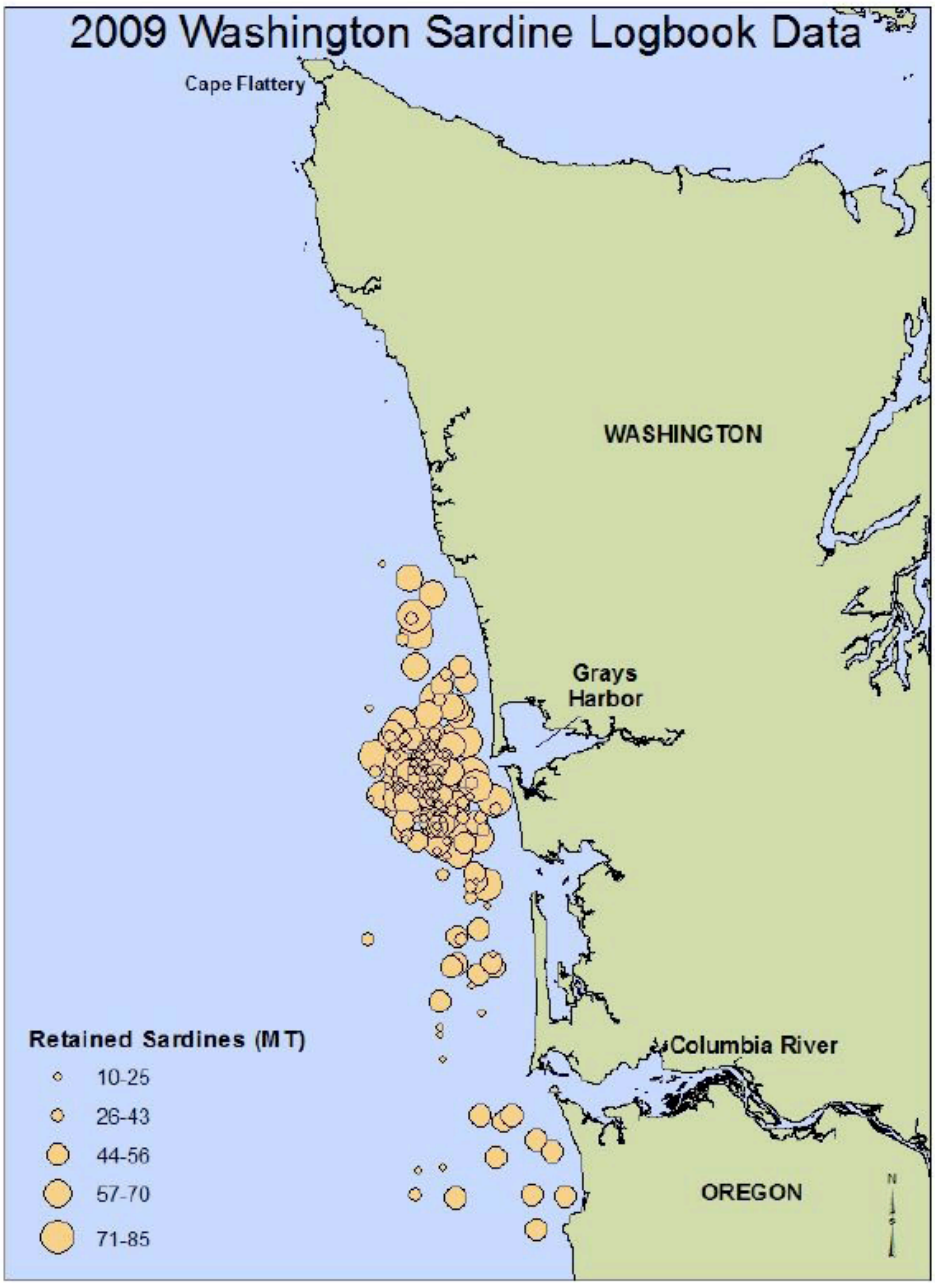

Figure 4. 2009 Washington sardine fishery set locations based on logbooks submitted to WDFW.

Figure 5. 2008 Oregon sardine fishery set locations based on logbooks submitted to ODFW.